

REMARKS

This Amendment responds to the Office Action dated March 10, 2004 in which the Examiner rejected claims 1, 8-10, 17-19, 26 and 27 under 35 U.S.C. § 102(b) and rejected claims 1-27 under 35 U.S.C. § 103.

Concurrently filed with this Amendment are replacement sheets to label Figures 1a-1c prior art.

As indicated above, claims 1, 8-10, 17-19, 26-27 have been amended to make explicit what is implicit in the claims. Applicant respectfully submits that the amendment is unrelated to a statutory requirement for patentability and does not narrow the literal scope of the claims.

Claims 1, 8 and 9 claim a method of patterning a thin film, a method of manufacturing a thin film device and a method of manufacturing a thin-film magnetic head. The various methods comprise the steps of forming at least one strippable film on a whole surface of a thin film to be patterned, patterning the at least one strippable film together with the thin film to be patterned by using focused ion beam etching and then removing the etched at least one strippable film.

Through the method of the claimed invention forming a strippable film on a whole surface of a thin film to be patterned, and patterning the strippable thin film together with the thin film using focused ion beam etching as claimed in claims 1, 8 and 9, the claimed invention provides a thin film to be patterned which is prevented from being damaged due to electric charge. In addition, pattern resolution or pattern precision can be improved. The prior art does not show, teach or suggest the invention as claimed in claims 1, 8 and 9.

Claims 10 claims a method of patterning a thin film, claim 17 claims a method of manufacturing a thin film device and claim 18 claims a method of manufacturing a thin film magnetic head. The methods comprise the steps of forming at least one strippable film, patterning the at least one strippable film using focused ion beam etching, forming a thin film to be patterned by using the etched at least one strippable film and removing the etched at least one strippable film.

Through the method of the claimed invention patterning at least one strippable film using focused ion beam etching and then forming a thin film to be patterned, as claimed in claims 10, 17 and 18, the claimed invention provides a thin film which is not directly etched by focused ion beam etching so that the thin film can be prevented from damage due to electric charge. The prior art does not show, teach or suggest the invention as claimed in claims 10, 17 and 18.

Claims 19 claims a method of patterning a thin film, claim 26 claims a method of manufacturing a thin film device, and claim 27 claims a method of manufacturing a thin-film magnetic head. The methods comprise the steps of forming at least one strippable film on a whole surface of a thin film to be patterned, patterning the at least one strippable film together with the first thin film to be patterned by using focused ion beam etching, forming a second thin film to be patterned using the at least one strippable film and the patterned first thin film to be patterned as a mask and removing the etched at least one strippable film.

Through the method of the claimed invention forming at least one strippable film on a whole surface of a thin film to be patterned, and etching the strippable film together with the first thin film using focused ion beam etching, as claimed in claims 19, 26 and 27, the claimed invention provides a thin film which is not directly etched

by focused ion beam etching so that the thin film is prevented from being damaged by electric charge. The prior art does not show, teach or suggest the invention as claimed in claims 19, 26 and 27.

Claims 1, 8 and 9 were rejected under 35 U.S.C. § 102(b) by *Kawabe et al.* (U.S. Patent No. 5,316,617).

Kawabe et al. appears to disclose first, as shown in FIG. 9A, successively formed on a substrate 12 were an alumina layer 14 as the base layer, a permalloy film 16 as the lower magnetic film, an alumina film 18 as the gap layer, a conductor coil 22 of copper, and an organic resin layer 20 as the insulator layer. Formed successively on the organic resin layer 20 were a permalloy film 24 as the upper magnetic film, an alumina film 26, and a permalloy film 28 constituting the mask for alumina etching. Subsequently, as shown in FIG. 9B, a photoresist pattern 30 was applied to the permalloy film 28. Then, as shown in FIG. 9C, using the photoresist 30 as a mask, patterning was performed on the permalloy film 28 by ion beam etching using Ar gas. Subsequently, the photoresist 30 was removed, and, as shown in FIG. 9D, patterning was performed on the alumina film 26 by ion beam etching using a mixture gas consisting of 37 vol% of $\text{CH}_2\text{F}_2 + \text{CHF}_3$. Since in this process the permalloy film 28 serving as a mask is not etched at all as stated above, its film thickness may be small; in this embodiment, it was 0.5 μm . For practical use, it is desirable that the film thickness be set at 1 μm or less taking into account the film thickness variation in the substrate or between batches, the film peripheral portions in the device step section, etc. The side edge surface tapered angle of the alumina pattern 26 thus obtained was 82°. Subsequently, as shown in FIG. 9E, using the alumina film 26 as a mask, etching was performed on the permalloy film 24

by ion beam etching using Ar gas. In this process, the permalloy film 28, which had been previously used as a mask, was automatically removed because of its small film thickness. In this way, a method of manufacturing a thin film magnetic head having a high precision track width was realized. (col. 9, lines 12-45)

Thus, *Kawabe et al.* merely discloses using photoresist 30 as a mask to pattern permalloy film 28 which is then patterned. Nothing in *Kawabe et al.* shows, teaches or suggests patterning a strippable film together with a thin film as claimed in claims 1, 8 and 9. Rather, *Kawabe et al.* merely discloses patterning photoresist 30 which is then used as a mask to pattern permalloy film 28.

Additionally, *Kawabe et al.* merely discloses forming the photoresist 30 on only a portion of the permalloy film 28. However, as claimed in claims 1, 8 and 9, the strippable film is formed on the whole surface of the thin film to be patterned. However, *Kawabe et al.* clearly teaches away from the claimed invention since the photoresist 30 is only formed on part of the permalloy film 28.

Finally, Applicant respectfully traverses the Examiner's statement that ion beam etching is the same as focused ion beam etching. Attached to this Amendment are excerpts discussing the difference between focused ion beam systems and regular ion beam etching. Applicant respectfully points out that focused ion beam etching use a finely focused beam of gallium ions. However, ion beam etching uses a broad beam which is collimated. Thus, clearly a broad beam type of etching is different from a focused beam. Additionally, Applicant respectfully points out that the focused ion beam is directly used to pattern the strippable film together with the thin film. However, in *Kawabe et al.*, masks are used in order to pattern the other film using the ion beam etching. Applicant finally points out to the Examiner

that focused ion beam uses a focus beam of gallium ions whereas the ion beam etching described in *Kawabe et al.* uses AR gas.

Since nothing in *Kawabe et al.* shows, teaches or suggests patterning a strippable film together with a thin film by focused ion beam etching as claimed in claims 1, 8 and 9, Applicant respectfully requests the Examiner withdraws the rejection to claims 1, 8 and 9 under 35 U.S.C. § 102(b).

Claims 1, 8 and 9 were rejected under 35 U.S.C. § 102(b) as being anticipated by *Hara et al.* (U.S. Patent No. 4,592,801).

Hara et al. appears to disclose in Fig. 4c shows a state that, after a photoresist material was applied to the whole surface of the alumina film 27 to form a photoresist film 28, and the photoresist film 28 has been exposed and developed so as to have a predetermined pattern which is identical with a final pattern of the upper permalloy film 23. FIG. 4d shows a state that an exposed portion of the alumina film 27 has been dry-etched by using the photoresist film 28 as a mask. The ion beam etching technique using a carbon fluoride gas was used for dry-etching the exposed portion of the alumina film 27. As shown in FIG. 4d, the photoresist film 28 on the remaining portion of the alumina film 27 is left, though the thickness of the film 28 is reduced. The photoresist film 28 does not change in property even after having been subjected to the ion beam etching which uses a carbon fluoride gas, and therefore can be readily removed by an oxygen plasma or an organic solvent such as acetone. FIG. 4e shows a state that the upper permalloy film 23 has been etched by carrying out argon ion beam etching while using the alumina film 27 as a mask, that is, a state that a patterning operation for the upper permalloy film 23 has been completed. If it is required to remove the alumina film 27 which has been used as

the mask, the alumina film 27 will be readily etched off by the ion beam etching which uses a carbon fluoride gas or by phosphoric acid. However, in order to reinforce the thin-film magnetic head, it is usually required to coat the magnetic head with an inorganic oxide material. (col. 5, lines 40-68)

Thus, *Hara et al.* merely discloses dry etching an alumina film 27 using a photoresist 28 as a mask and then etching an upper permalloy film 23 while using the alumina film 27 as a mask. Nothing in *Hara et al.* shows, teaches or suggests patterning a strippable film together with a thin film as claimed in claims 1, 8 and 9. Rather, *Hara et al.* merely discloses dry etching an alumina film and then etching an upper permalloy film using the alumina film as a mask.

Additionally, as discussed above, *Hara et al.* merely discloses ion beam etching using a carbon fluoride to dry etch the alumina film 27 while permalloy film 23 is etched using an argon ion beam etching. Thus, nothing in *Hara et al.* shows, teaches or suggests focused ion beam etching which directly patterns both a strippable film together with a thin film as claimed in claims 1, 8 and 9. Rather, *Hara et al.* merely discloses using a carbon fluoride gas to etch an alumina film 27 while argon ion beam etching is used to etch a permalloy film.

Since nothing in *Hara et al.* shows, teaches or suggests patterning a strippable film together with a thin film pattern using a focused ion beam etching as claimed in claims 1, 8 and 9, Applicant respectfully requests the Examiner withdraws the rejection to claims 1, 8 and 9 under 35 U.S.C. § 102(b).

Claims 1, 8-10, 17-19, 26 and 27 were rejected under 35 U.S.C. § 102(b) as being anticipated by, or in the alternative under 35 U.S.C. § 103 as obvious over, *Nakamura et al.* (U.S. Patent No. 5,506,197).

Nakamura et al. appears to disclose as shown in FIG. 3A, an MgO (100) substrate 5 is prepared. As shown in FIG. 3B, a c-axis oriented $Y_1Ba_2Cu_3O_{7-\delta}$ oxide superconductor thin film 1 having a thickness of about 250 nanometers is deposited on a principal surface of a MgO substrate 5. (col. 10, lines 23-27) Then, as shown in FIG. 3C, an Au layer 14 having a thickness of 30 to 100 nanometers is formed on the $Y_1Ba_2Cu_3O_{7-\delta}$ oxide superconductor thin film 1. As shown in FIG. 3D, a SiO_2 layer 15 having a thickness of 250 nanometers is formed on the Au layer 14 by a CVD. A center portion of the SiO_2 layer 15 is removed by using a photolithography. Using the processed SiO_2 layer 15 as a mask, center portions of the Au layer 14 and the $Y_1Ba_2Cu_3O_{7-\delta}$ oxide superconductor thin film 1 are selectively etched by a reactive ion etching using a chloric gas, an ion milling using Ar-ions or a focused ion beam etching so that the Au layer 14 is divided into a source electrode 12 and a drain electrode 13, the $Y_1Ba_2Cu_3O_{7-\delta}$ oxide superconductor thin film 1 is divided into a superconducting source region 2 and a superconducting drain region 3, and a portion 16 of the surface of the substrate 5 is exposed between them, as shown in FIG. 3E. As shown in FIG. 3F, an oxide layer 20 composed of c-axis oriented $Pr_1Ba_2Cu_3O_{7-\epsilon}$ is deposited on the exposed surface 16 of the substrate 5, by an MBE. The oxide layer 20 preferably has a half thickness of the superconducting source region 2 and the superconducting drain region 3. (col. 10, lines 38-54)

Thus, *Nakamura et al.* merely discloses using photolithography to remove a portion of a layer 15 (col. 10, lines 42-44). Thus, nothing in *Nakamura et al.* shows, teaches or suggests patterning a strippable film by focused ion beam etching as claimed in claims 1, 8-10, 17-19 and 26-27. Rather, *Nakamura et al.* merely discloses using photolithography to partially remove the center portion of layer 15.

Applicant respectfully brings the Examiner's attention to the attachment entitled "Semiconductor Fabrication Technology." As can be seen from this, photolithography is entirely different from etching techniques (see pages 1 and 2 versus pages 4-5).

Additionally, *Nakamura et al.* merely discloses that the processed layer 15 is used as a mask so that center portions of a layer 14 and a thin film layer 1 are selectively etched. Nothing in *Nakamura et al.* shows, teaches or suggests patterning a strippable film using focused ion beam etching as claimed in claims 1, 8-10, 17-19 and 26-27. Rather, *Nakamura et al.* merely discloses etching a center portion of a layer 14 and a thin film 1 using a process layer 15 as a mask. In other words, the strippable film layer 15 is never etched using focused ion beam since the center portion of layer 15 was removed by photolithography.

Since nothing in *Nakamura et al.* shows, teaches or suggests patterning a strippable film by focused ion beam etching as claimed in claims 1, 8-10, 17-19 and 26 and 27, Applicant respectfully requests the Examiner withdraws the rejection to claims 1, 8-10, 17-19, and 26-27 under 35 U.S.C. § 102(b).

Claims 1-9 were rejected under 35 U.S.C. § 103 as being unpatentable over *Taylor et al.* (U.S. Patent No. 4,377,437).

Taylor et al. appears to disclose a lithography technique for use in the production of solid state devices. (col. 1, lines 8-9) It is desirable to obtain resist materials that can be exposed with relatively low energy ion beams while achieving fine line pattern generation. (col. 1, lines 64-66) A lithographic process is disclosed whereby ions are selectively implanted in a material and subsequently exposed to a reactive atmosphere. The implanted species react with the reactive atmosphere to

form a nonvolatile protective compound in the implanted regions of the material, so that such protected regions are etched at a slower rate than unprotected regions when the material is exposed to a plasma. Typically, the reactive atmosphere used to form the protective compound is also the plasma used for etching. A negative tone pattern is thereby produced in the material. (col. 2, lines 5-16) The following detailed description relates to a lithography process whereby ions are selectively implanted into a material and subsequently treated to form a negative tone pattern in the material. (col. 2, lines 23-26) The ionic species, typically implanted to a mean depth less than 50 percent of the thickness of the material being implanted, is subsequently treated with a reactive atmosphere, typically an oxygen or halogen-containing plasma, to form a protective compound in the implanted regions of the material. (col. 2, lines 33-38) The material is then etched in a plasma so that the unprotected regions are removed at a faster rate than the protected regions, yielding a negative tone pattern. (col. 2, lines 43-46)

Thus, *Taylor et al.* is merely directed to a lithography technique in which resist materials can be exposed to a relatively low energy beam in order to subsequently etch them into a fine line pattern. Nothing in *Taylor et al.* does not shows, teaches or suggests a) a method of patterning a thin film, b) a method of manufacturing a thin film device or c) a method of manufacturing a thin-film magnetic head as claimed in claims 1, 8 and 9. Rather, *Taylor et al.* is directed to a lithography technique in which ions are selectively implanted and subsequently exposed in a reactive atmosphere to produce a negative tone pattern.

Additionally, since *Taylor et al.* is directed to a lithography technique for producing a negative tone pattern, nothing in *Taylor et al.* shows, teaches or

suggests forming at least one strippable film on a whole surface of a thin film to be patterned and patterning the strippable film together with the thin film using focused ion beam etching as claimed in claims 1, 8 and 9. Rather, *Taylor et al.* is merely directed to selectively implanting materials and subsequently treating to form a negative tone pattern in the material.

Since nothing in *Taylor et al.* shows, teaches or suggests or suggests a method of patterning a thin film, method of manufacturing a thin film device, method of manufacturing a thin-film magnetic head, forming at least one strippable film on a whole surface of a thin film to be patterned and patterning the at least one strippable film together with the thin film using focused ion beam etching as claimed in claims 1, 8 and 9, Applicant respectfully requests the Examiner withdraw the rejection to claims 1, 8 and 9 under 35 U.S.C. § 103.

Claims 2-7 depend from claim 1 and recite additional features. Applicant respectfully submits that claims 2-7 would not have been obvious within the meaning of 35 U.S.C. § 103 over *Taylor et al.* at least for the reasons as set forth above. Therefore, Applicants respectfully requests the Examiner withdraw the rejection to claims 2-7 under 35 U.S.C. § 103.

Claims 11-16 and 20-25 were rejected under 35 U.S.C. § 103 as being unpatentable over *Nakamura et al.* and further in view of *Taylor et al.*

As discussed above, *Nakamura et al.* merely discloses using photolithography to remove a center portion of a layer 15 and subsequently selectively etching the center portions of a layer 14 and thin film layer 1. Nothing in *Nakamura et al.* shows, teaches or suggests patterning a strippable film together with a thin film using focused ion beam etching as claimed in claim 19. Rather, *Nakamura et al.* merely

discloses removing a processing layer 15 using photolithography techniques and then selectively etching center portions of a layer 14 and thin film layer 1.

As discussed above, *Taylor et al.* is merely directed to a lithography process whereby ions are selectively implanted into a material and subsequently treated to form a negative tone pattern in the material. Nothing in *Taylor et al.* shows, teaches or suggests a method of patterning a thin film including forming at least one strippable film on a whole surface of a first thin film to be patterned, and patterning the at least one strippable film together with the thin film using focused ion beam etching as claimed in claim 19. Furthermore, nothing in *Taylor et al.* shows, teaches or suggests forming a second thin film to be patterned using the etched strippable film and first thin film as a mask and then removing the etched strippable film as claimed in claim 19.

The combination of *Nakamura et al.* and *Taylor et al.* would merely suggest that in order to remove the layer 15 of *Nakamura et al.* using photolithography to first implant ions into the material as taught by *Taylor et al.* Thus, nothing in the combination of *Nakamura* and *Taylor* show, teach or suggest the features as claimed in claim 19. Therefore, Applicant respectfully requests the Examiner withdraws the rejection to claim 19 under 35 U.S.C. § 103.

Claims 11-16 and 20-25 depend from claims 10 and 19 and recite additional features. Applicant respectfully submits claims 11-16 and 19-25 would not have been obvious within the meaning of 35 U.S.C. § 103 at least for the reasons as set forth above. Therefore, Applicant respectfully requests the Examiner withdraws the rejection to claims 11-16 and 20-25 under 35 U.S.C. § 103.

Thus it now appears that the application is in condition for reconsideration and allowance. Reconsideration and allowance at an early date are respectfully requested.

If for any reason the Examiner feels that the application is not now in condition for allowance, the Examiner is requested to contact, by telephone, the Applicants' undersigned attorney at the indicated telephone number to arrange for an interview to expedite the disposition of this case.

In the event that this paper is not timely filed within the currently set shortened statutory period, Applicants respectfully petition for an appropriate extension of time. The fees for such extension of time may be charged to our Deposit Account No. 02-4800.

In the event that any additional fees are due with this paper, please charge our Deposit Account No. 02-4800.

Respectfully submitted,

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